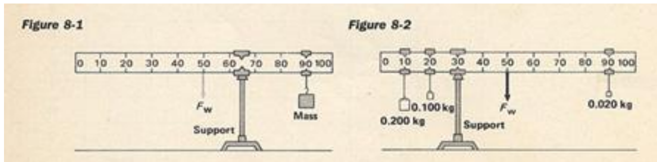
Name:______________________________

Experiment: Torque, See-Saws and Equilibrium

Introduction:

The see-saw is a simple device that is free to rotate about a pivot or fulcrum. Consider a large person (M=100kg) sitting on a see-saw at 2.0m from the fulcrum. On the opposite side is a child (m=20kg). **To balance the see-saw, how far from the fulcrum must the child sit?** Our lab will investigate situations similar to this.

We will use meter stick see-saws to learn about torque, the cause of all rotation, and rotational equilibrium, and center of gravity. We will discover how to describe forces and torques mathematically and solve the problem posted in the previous paragraph.



Procedures:

Part A—Learning about torque:

1. Place the knife edge fulcrum device at the center of mass of the meter stick. This should be near the center. You will know the knife edge is at the center of mass when the meter stick balances.
2. Suspend a 200g mass 10cm from the fulcrum. Don't forget to account for the mass of the hanger and the clamp in your table.
3. Now suspend a 100g mass on the opposite side of the fulcrum at the point that re-establishes balance. Record the masses and distances from the fulcrum. Consider: How is it that a lighter mass can balance out a heavier one?
4. Adjust the heavier mass value to 20cm from the fulcrum and bring it to balance (Rotational Equilibrium) with the left mass. Record your data in the table
5. Adjust the heavier mass to 30cm from the fulcrum and bring it to balance (Rotational Equilibrium) with the left mass.

Left: Small Mass (g)	Left: Distance from Fulcrum (cm)	Right: Large Mass (g)	Right: Distance from Fulcrum (cm)
100 + hanger + clamp m=_________		200 + hanger + clamp m=_________	10
			20
			30

6. Show mathematically why each of these masses balance off using $F_L d_L = \tau = F_R\, d_R$

Part B- Determine the mass of your meter stick.

1. Remove all of the mass hangers.
2. Record the location where the knife edge fulcrum is located when the meter stick is balanced. This is called the center of mass.
3. Place the knife edge fulcrum at the 35 cm mark of your meter stick.
4. Record the distance from the 35cm mark to the center of mass under d_{right}
5. Place a mass hanger on the 0-35cm side of the meter stick with a mass of 50 g
6. Move the mass hanger to the location where the system becomes in balanced. Take note this point is where you have achieved rotational equilibrium.

F_{left}	d_{left}	|Torque| left	F_{right}	d_{right}	|Torque| right	mass right

7. Determine the mass of the meter stick?

8. What is causing the rotation, the force or the distance?

9. Torques direction is not considered up and down but clockwise and couter clockwise. To determine this you look at the fulcrum as the pivot point and you look at the direction the lever arm moves from the fulcrum. If it is moving in the direction of a clock hand then we call this clockwise. If it is moving opposite this direction it is moving counter clockwise. In part B which direction is the cause of the rotation by weight of the ruler?

10. Which direction is the cause of the rotation by hanging mass?

<u>Part C</u>

Application-Make an off centered scale. (Show all work in the space below)

1. Place the fulcrum at the 85cm mark. Balance the meter stick using a single known mass (you must place it correctly to do this).
2. Draw a diagram of the "See-Saw". Label the fulcrum and the two masses producing the torques. One mass is the known mass—what is the other mass. Where is that other mass located (all of it at one place—where).
3. Use your torque relation to determine the mass of the meter stick.
4. Place the meter stick on the commercial balance to verify your determination.
5. If your results don't agree, go back and think about what you did in step 2.

Calculations from this lab are to prove with math your experimental values. You can use the calculated value as your theoretical value and the experimental as the experimental. Calculate percent error for each trial.